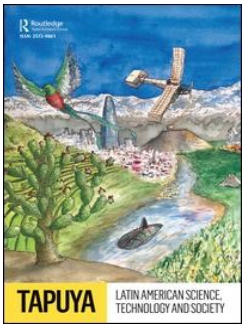
Proximal Design in South African Informal Settlements: Users as Designers and the Construction of the Built Environment and its Fire Risks



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Proximal design in South African informal settlements: users as designers and the construction of the built environment and its fire risks

Graham Spinardi[a], S.J. Cooper-Knock[b] and David Rush [a]

[a]School of Engineering, University of Edinburgh, Edinburgh, UK; [b]ACMS, University of the Witwatersrand, Johannesburg, South Africa

ABSTRACT

Informal settlements present a challenge for fire safety because they lack the regulation of building standards that have been central to reducing fire risks elsewhere. Rather than being the product of specialist designers (such as architects and engineers), constrained by regulation, informal settlement dwellings are instead predominantly the work of their occupants. Thus, the design and construction of informal settlement structures can be understood as a result of *proximal design* by the residents themselves – drawing on the concept proposed by Usenyuk et al. in their 2016 paper "Proximal Design: Users as Designers of Mobility in the Russian North." This paper applies, and critiques, the proximal design concept through a focus on the informal settlement fire problem in South Africa. Our case study points to weaknesses in the way that Usenyuk et al. apply the concept of proximal design. Not only do Usenyuk et al. emphasize that proximal design involves mastery of a severe environment, but they also fail to give sufficient attention to the social context. Although a focus on proximal design provides insights into the informal settlement fire problem, it is vital that the focus on proximate activities does not obscure the importance of broader societal factors.

KEYWORDS
Informal settlements; fire safety; proximal design

PALAVRAS-CHAVE
Assentamentos informais; segurança contra incêndios; proximal design

PALABRAS CLAVE
Asentamientos informales; seguridad contra incendios; proximal design

"Proximal Design" em favelas sul-africanas: Os residentes no centro do projeto e da construção, e os riscos de fogo associados

RESUMO

As favelas (*informal settlements*) constituem um desafio para a segurança contra incêndios, uma vez que não seguem a regulamentação e normas essenciais na redução dos riscos de incêndio operantes em outras áreas da indústria da construção. As favelas não são projetadas e construídas por especialistas (tais como arquitetos e engenheiros), seguindo normas existentes, mas sim predominantemente pelos próprios ocupantes. O projeto e construção de favelas pode, consequentemente, ser

CONTACT Graham Spinardi g.spinardi@ed.ac.uk

compreendido como o resultado de um processo de *proximal design* pelos próprios residentes, de acordo com o conceito proposto por Usenyuk et al. em 2016 no artigo "Proximal Design: Users as Designers of Mobility in the Russian North." O trabalho que aqui se apresenta descreve o conceito de "proximal design" numa perspectiva de análise crítica, focando-se na problemática real do risco de incêndios em favelas na África do Sul. Este estudo de caso aponta as debilidades na forma como Usenyuk et al. aplicam o conceito de "proximal design." Usenyuk et al. não só salientam que este conceito implica que as comunidades envolvidas dominem um conjunto de fatores ambientais potencialmente severos, mas também ficam sem dar atenção suficiente ao contexto social em que as favelas se inserem. Apesar do foco no "proximal design" ser indubitavelmente uma fonte de informação essencial para o problema dos incêndios em favelas, é essencial que o foco das atividades associadas à proximidade não minimize a importância dos fatores sociais inerentes ao problema.

"Proximal Design" en asentamientos informales sudafricanos: usuarios como diseñadores, y la construcción del medio urbano y su riesgo de incendio

RESUMEN

Los asentamientos informales presentan retos para la seguridad contra incendios, ya que carecen de regulación para los estándares de construcción, lo cual ha sido imprescindible para la reducción del riesgo de incendios en otros lugares. En lugar de ser el producto de diseñadores especializados (tales como arquitectos e ingenieros), los cuales están limitados por las regulaciones, las viviendas en asentamientos informales surgen predominantemente del trabajo de sus habitantes. Por tanto, el diseño y construcción de estructuras en asentamientos informales puede ser entendido como el resultado del *proximal design* por parte de los residentes – partiendo del concepto propuesto por Usenyuk et al. en su artículo de 2016 "Proximal Design: Users as Designers of Mobility in the Russian North." Este artículo aplica y critica el concepto de "proximal design" a partir del problema de los fuegos en asentamientos informales en Sudáfrica. Nuestro caso de estudio resalta las debilidades en la forma en la que Usenyuk et al. aplican el concepto de "proximal design." Usenyuk et al. no solo enfatizan el hecho de que el "proximal design" requiere el dominio de ambientes extremos, sino que además no prestan suficiente atención al contexto social. Aunque el enfoque del "proximal design" provee información sobre el problema de los incendios en asentamientos informales, es esencial que dicho enfoque no oculte la importancia de los factores sociales.

1. Introduction

In many countries, deaths and injuries due to fire in urban areas have been reduced by more equitable infrastructure, more affordable and accessible formal housing, and the provision of state services, including urban planning, professional fire-fighting services,

and building regulations (Rush et al. 2020). Such developments have proved more challenging in low-and-middle-income countries, where 95% of the world's fire deaths and morbidity remain (WHO 2018). Fire risk is particularly stark in informal settlements, which currently house one billion people across the globe. In Africa alone, this number is expected to grow to 1.2 billion by 2050 (UN-Habitat 2016). The definition of an informal settlement varies, but in the case of South Africa, it is often referred to as an "unplanned settlement on land which has not been surveyed or proclaimed as residential, consisting mainly of informal dwellings (shacks)" (SSA 2012).

Across the nation, informal settlements fires occur daily in South Africa (Rush et al. 2020), and conflagrations that destroy many dwellings occur with disturbing regularity. Although statistics on fire are limited in scope and quality (Twigg et al. 2017), they indicate that fire instance and its impact are substantial. The vulnerability of these communities to fire is high, with the potential for a major fire disaster. Even where loss of life is low, frequent fires ruin lives, damage property, and undermine socio-economic development. These fires, therefore, constitute an "extensive risk," as defined by UNISDR (2009).

In recent years, there has been a growing interest in exploring fire risk and reduction within informal settlements. This interest is welcome, but interventions will only be successful to the degree that they take people's lived realities in such settlements seriously (Chance 2018; Rush et al. 2020).

One concept that seems promising in this regard is the idea of "proximal design" (Usenyuk, Hyysalo, and Whalen 2016). This concept encourages us to explore the ways in which users design or adapt technologies in order to meet the needs of their environment. The advantage of this approach is that it allows us to acknowledge the crucial role that residents play in the design, construction and maintenance of informal settlements. Urban planning officials and formally trained engineers[1] are not usually involved in the creation of informal settlements, entering only as part of formal "upgrading" projects. Typically, the ongoing (re)construction of the built environment is the result of *in situ* "social practices" (Shove 2003; Spaargaren 2003) rather than state regulation. Usenyuk, Hyysalo, and Whalen's (2016) work can help us to see "design" as an ongoing process within informal settlements, shaped more by the expertise of direct experience and exigencies of daily life than state regulation and institutions.

"Proximal design" is clearly essential to understanding how the social and material interact in constructing fire risk in informal settlements. In its current form, however, it is ultimately insufficient. We argue that Usenyuk, Hyysalo, and Whalen's (2016) deployment of the concept leaves us with a romanticized notion of user-design that fails to take seriously the structural social, economic and political context in which this design occurs. To correct this shortcoming, we need to conceptually expand the notion "proximal design" and change the methods we use to study it. In other words, we need not just to "study down," but also to "study up" (Nader 1972). Using the terminology of the Social Construction of Technology (SCOT) approach set out by Pinch and Bijker (1984), we need to be careful to capture the roles of *all* the "relevant social groups," and not just those that are most visible on the ground.

[1]This is not to minimize the professional expertise that does exist within informal settlements, including that of construction workers, electricians and plumbers who may live in the community, but to emphasize the lack of state regulatory oversight and formalized building standards in design and construction.

Our argument proceeds as follows: We begin by establishing the fire risk present within informal settlements, which exists both despite and because of the designs that user-makers create. We argue that this is the key shortcoming of Usenyuk et al.'s concept: it fails to take the limits of proximal design, and the structural drivers of those limits, seriously. Having established the limitations of Usenyuk, Hyysalo, and Whalen's (2016) concept, we explore some of the wider drivers of user-maker decisions in South Africa and their implications for fire safety interventions. We conclude that these contextual factors do not leave us with any easy solutions to the issues of fire-risk within informal settlements. They do, however, give us a better sense of the questions we should ask of such interventions. In making this argument, we draw on interviews, site visits, observation, as well as the broader literature. Interviews were carried out by different authors. A survey of 600 informal settlement residents across six settlements was conducted by Social Surveys Africa between 2018 and 2019; around 20 interviews with fire service and disaster management personnel and City of Cape Town officials were carried out by Spinardi and Cooper-Knock between 2016 and 2020; Cooper-Knock, Fiona Anciano and Mfundo Majola conducted interviews with 18 residents of Imizamo Yethu between 2018 and 2019; Cooper-Knock and Kanyisile Brukwe conducted 11 focus groups and 10 interviews across 10 settlements in Cape Town in 2019; and Cooper-Knock conducted 20 interviews across 3 settlements in eThekwini, 12 of which were conducted with Sifiso Ngongoma, between 2018 and 2019. Cooper-Knock also participated in re-blocking planning meetings in Mshini Wam with Kanyisile Brukwe and participated in movement meetings with the Informal Settlement Network and Abahlali baseMjondolo during this period. Where interviews have been conducted with other researchers, their permission has been sought for inclusion within this paper.

2. Informal settlement fire and proximal design: setting the scene

Informal settlement fires are commonplace in South Africa. In Cape Town alone, according to the chief fire officer,[2] "there's only four of five days on average a year when we don't respond to one," and Cape Town Fire and Rescue Service reports over 1000 fire incidents (that it attends) in informal settlements annually (Anon 2013b). The City of Cape Town has estimated that over 100 people die each year in informal settlement dwellings fires within its boundaries (Sacks 2013). In 2011, this figure peaked at 151 (Davis 2015). As well as fatalities, informal settlement fires cause widespread injury and homelessness. In the settlement of Masiphumelele, for example, a fire in November 2015 left 2 dead and 4000 homeless. In Imizamo Yethu, a fire in March 2017 left 4 dead, and over 10,000 homeless (Walls, Oliver, and Eksteen 2017). The fear, loss, and devastation that fire brings – and the subsequent displacement and disruption it causes – result in personal and communal trauma; material loss; fractured social support networks; and compromised access to services (e.g. a lack of access to critical medication) (Birkinshaw 2008).[3]

In recognition of the dire consequences of informal settlement fires in South Africa, there have been widespread attempts to limit their incidence and their spread. Many of these interventions start from the premise that informal settlement fire can only be eliminated through the provision of safe, accessible and affordable housing but that

[2]Interview, 20 January 2016.
[3]Imizamo Yethu Resident interview, 4 April 2018.

such housing will not be imminently available. Therefore, they seek to offer short-to-medium term mitigations to tackle fire risk, including education, fire alarms, intumescent paint, new forms of construction material, and the re-blocking of informal settlements (Walls et al. 2019).

As political anthropologists remind us, however, interventions to "improve" people's lives will only be successful to the degree that they actually meet people's lived realities (Scott 1999; Li 2005). Otherwise, they stand to be resisted, ignored or subverted in practice. The concept of "proximal design" (Usenyuk, Hyysalo, and Whalen 2016) seems well-suited to this end. This is a theoretical concept that seeks to take the experiential expertise of people on the ground seriously, thinking through the decisions that they make in designing and adapting different technologies to suit their needs. According to Usenyuk, Hyysalo, and Whalen (2016, 867) "proximal design" entails "engaging in thoroughgoing design and manufacturing activities locally in order to make the technology fully adequate and appropriate for local needs." In a context where there has been a long-running tendency to value the technical expertise of engineers, architects and planners over the experience and expertise of informal settlement residents, the potential of this theoretical approach is clear.

Usenyuk, Hyysalo, and Whalen's (2016) approach builds on work in the history of technology and STS that demonstrates the role of users in adapting technology, often subverting the intentions of the designers, in what is sometimes referred to as "domestication" (Cowan 1983; Kline and Pinch 1996; Lie and Sorensen 1996). This emphasis on the role of users addresses some of the criticisms of STS approaches such as the Social Construction of Technology (Pinch and Bijker 1984) that were seen to focus too narrowly on the design process and on the stabilization of the design through "closure," thus favoring a status quo perspective and excluding those not visible as "relevant social groups" (Russell 1986).

As set out by Usenyuk, Hyysalo, and Whalen (2016, 868) the concept of "proximal design" differs from earlier notions of the "domestication" of technology because it does not "presume that enduring design principles and more architectural aspects of design emerge only from professional engineers and designers." The examples of transportation technologies used by Usenyuk, Hyysalo, and Whalen (2016) are located in the inhospitable Russian North, and stress is laid on the importance of "the environment," "the challenges of nature," and "distance" in creating the need for proximal design. Proximal design is thus seen as local adaptation that is necessary to overcome the challenges of this severe physical environment, and their case studies portray a heroic narrative of success. For example, in the case of indigenous sled development, it is stated that "people make objects for themselves, in order to reach a perfect match with their things and – through them – to be able to withstand a severe environment" (Usenyuk, Hyysalo, and Whalen 2016, 894).

One test of a good concept is its generality. At first glance, this approach seems to be a productive way of centering the experiences of informal settlement residents as user-makers in our analysis. In this paper, we adopt the proximal design approach in our initial framing of the informal settlement fire problem. In doing so, however, we reflect on whether our empirical case study – markedly different from that of Usenyuk, Hyysalo, and Whalen (2016) in some ways – provides insights that can broaden our understanding of proximal design. We conclude that "proximal design" in its current form ultimately leaves us with a romanticized idea of the design process that makes the individual

user-maker responsible for any resulting limitations. We need to move beyond heroic narratives of user-makers mastering severe physical environments. Only by understanding the social, political and economic environments in which proximal design occurs, we argue, can we understand the choices that user-makers take and its implications for fire risk within informal settlements.

3. The limits of proximal design

Like the Russian North, South African informal settlements present "stimulatory environments for technological invention" in which "*continuous tuning and modification* of technology carried out by immediate users in situ becomes the way for humans and machines to function and co-exist" (Usenyuk, Hyysalo, and Whalen 2016, 895, emphasis in original). In our case, the "machines" are relatively simple in nature, comprising structures to provide security, comfort, and shelter from the weather. In this section, we argue, however, that the development and use of informal settlement dwellings should not be depicted as a straightforward tale of "human mastery" of a "severe environment." Human ingenuity and fortitude are indeed central to the innovation process, but the resulting artifacts cannot be understood as simply the result of human against nature, nor as producing perfectly harmonious outcomes.

In South Africa, most informal settlement dwellings have been built by informal settlement residents (Bolnick and Bradlow 2010, 35). Furthermore, the users of informal settlement structures are involved in ongoing projects of construction, improvement and adaptation. This is not to ignore the rental and property markets within these settlements. The size and function of rental markets vary between settlements, but our survey of 600 residents across 6 settlements in Cape Town suggests that ownership is the dominant form of tenure, with under 15% of respondents reporting that they rented.[4] Understanding the transfer of this ownership between residents is more complex, because the property market within informal settlements is illicit. Muzondo et al.'s (2004) study of Wallacedene suggested a 30% divergence between state records of ownership and occupation. This represents a significant minority of homes but it does not detract from the premise that many dwellings are originally built by informal settlement residents, even if they are later rented or sold. Moreover, new occupants continue to be involved in maintenance, improvement and adaptation. Therefore, we would argue, the user-designer principle holds. Indeed, the utility of the "proximal design" (Usenyuk, Hyysalo, and Whalen 2016) concept is precisely that it allows us to recognize the crucial role that residents play in the design, construction and maintenance of informal dwellings and informal settlements as a whole.[5]

The outcome of proximal design within informal settlements, however, is not a "perfect match" to people's needs. Despite the creativity and skill of informal settlement residents, the dwellings that they construct and adapt fall short on several measures. In the context of this article, we focus on the limitations of informal dwellings in relation to fire safety. A

[4]In practice, any survey will struggle to capture the more-or-less formalized arrangements people have when staying in a household, which include diverse forms of reciprocity, exchange and obligation (Smit 2006, 110).

[5]Phantsi Kocingo resident interview, 1 April 2019; Ramaphosa Leadership interview, 24 March 2019. Both testify to the important role that residents play on the layout of the settlement as a whole, not just the planning of individual dwellings.

typical South African informal settlement dwelling comprises wooden posts to which metal sheeting is attached (Smit 2006, 110), though many materials can be used depending on the local context and household resources, and plastic or cardboard may be used for insulation (IRIS Fire 2018). There is no state-enforced regulation that effectively ensures the safety of these structures, and many of the materials used in informal settlement dwellings, as well as their contents, are readily ignitable (they ignite quickly with little energy required) and highly combustible (when ignited they release a lot of energy) (Walls, Oliver, and Eksteen 2017). In addition, residents (or prospective residents) build upon, and make use of, whatever space their neighbors, and the communities and local authorities, will allow.[6] Consequently, informal settlement structures may be closely co-located, with a great risk of fire spreading from the dwelling where it first started to others, sometimes resulting in conflagrations that destroy many homes.[7] Whilst densities differ from settlement to settlement (and between sections within a settlement), they can be high.[8] In Kayamandi, for example, on the outskirts of Stellenbosch, an enumeration in 2004 estimated that there were 2781 informal dwellings and a population of around 22,000 within about 1 km square (du Toit 2009, 73).

In short, it is clear that South African informal settlements are vulnerable to fire, and that this vulnerability is one of the properties of the "technology" produced as the residents seek to cope with the exigencies of the "severe environment" they face (Usenyuk, Hyysalo, and Whalen 2016, 897). Here we encounter the limited utility of Usenyuk, Hyysalo, and Whalen's (2016) work. In their article, they describe the vehicles created by proximal design as "functional, reliable, and, indeed beautiful" objects that are "fully adequate and appropriate for local needs." Within informal settlements, we argue, this verdict cannot hold because residents are exercising ingenuity and expertise in structurally constrained conditions. These structural constraints compromise residents' designs and force them to trade-off between multiple "goods" such as insulation and fire safety. Usenyuk, Hyysalo, and Whalen's (2016) focus purely on proximal action provides no analytical room for such discussions. The consequences of this analytical limitation are stark: user-makers become responsible for "making full use of the proximal sources through developing relevant skills and at most supplementing them with distantly produced details/technologies" (Usenyuk, Hyysalo, and Whalen 2016, 895). This would suggest that while vehicle user-makers in the Russian North are successful in mastering their environment through innovation, informal settlements residents in South Africa are failing due to their own poor design choices. That conclusion over-emphasizes the heroic mastery of the environment in the former and the culpability of informal settlements in the latter.

By failing to take full account of the interplay with structure and agency, we fail to accurately appraise both the realities in which people live and the technologies they produce. Thus, from an STS perspective, Usenyuk, Hyysalo, and Whalen (2016) fail to adopt the "symmetry principle" (Pinch and Bijker 1984), which demands that we attend to the success and failure of any technology. More broadly, their writing falls into a long-running problem within the social sciences: a romanticized account of human

[6]California resident interview, 2 July 2019.
[7]Burundi Focus Group, 30 July 2019.
[8]Block Six Leadership interview, 4 July 2019.

progress, which fails to hold the complexity of lives lived amidst hardship. Thus Ismail (2014, 274) argues that accounts of everyday life must capture people's humanity, dignity, organization, agency and achievements whilst refusing to "romanticize or idealize the hardships and struggles." For there is, as Adiche (2009) reminds us, a "danger [in telling] a single story." To underplay the functionality, reliability and beauty within informal settlements would be to do a disservice to the material structures and aesthetics of these spaces as well as the humanity and dignity of those who created them. And yet, to romanticize informal settlements is also to undermine that same humanity and dignity: it is to ignore the disgust, anger and insecurity that informal settlement residents themselves express at some of the conditions in which they are forced to live.[9]

In order to fully understand "the environment" in which informal settlement residents are operating, we must look beyond the terrain and the climate, and consider the political, social and economic context in which proximal design occurs. This requires us to both "study up" as well as "study down" in order to grasp how economic constraints, state interventions and intra-community politics, amongst other factors, have shaped the choices of user-makers.

4. Towards a structurally informed understanding of "proximal design"

Having established the limitations of "proximal design" as a concept, the following section highlights some of the challenges that informal settlement residents face as a consequence of their social, economic and political context. Before delving into the specifics of these factors, it is important to grasp something of the role that housing has played in the political history of South Africa.

"The struggle for liberation in South Africa," Asmal argued, "was not only a struggle for the right to vote, to move, to marry or to love. It has always been a struggle for freedom from hunger, poverty, landlessness, and homelessness" (in Christiansen 2006, 3). These aspirations were captured in the African National Congress' election promise of a "Better Life For All" in 1994. Two years later, South Africa had a constitution with some of the most comprehensive socio-economic rights in the world, including the right to "adequate housing" (Madlingozi 2007). The proportion of people living in informal dwellings, however, only incrementally decreased from 16.2% in 1996 to 13% in 2016 (SSA 2016). This includes both those who are living in "backyard shacks" (i.e. an informal dwelling in the yard of a formal dwelling) and those within informal settlements (SSA 2016). Within Cape Town, the 2011 census estimated that 20.5% of residents lived within informal dwellings (CCT 2012).

The persistence of informal dwellings in South Africa is testament to a lack of affordable, accessible formal housing. South Africa's Department of Human Settlements claims that it has built 3.2 million housing units for its poorest citizens between 1994 and 2018 (BBC 2019). The quality and location of these housing units, however, has been criticized (Brown-Luthango, Reyes, and Gubevu 2017, 473–474). Ultimately, the government has not delivered houses – in form or number – to meet the demands of an urbanizing population. Highlighting these shortcomings is crucial. That said, we should not overlook the importance of what has been delivered or the important shifts in policy

[9]https://www.theguardian.com/world/2012/sep/24/south-africa-shack-bahlali-basejondolo.

approaches to housing delivery over this period. Breaking New Ground (2004) marked a significant policy shift by the national government (Huchzermeyer 2006, 41). This policy stemmed from the acknowledgement that the state's dominant mode of housing delivery – greenfield development on the urban edge – was not working. In this policy and those that followed, the state designed instruments to support *in situ* upgrading within informal settlements and mixed-income greenfield development (Cirolia et al. 2017, 3). In practice, however, there is still a large gap between these ideals and their implementation – due to complexities in the relationship between government tiers, the shortcomings of policy instruments, and the politics of these processes at all levels (Huchzermeyer 2006; Cirolia et al. 2017; Anciano and Piper 2019).

Thus, despite a stated commitment to "adequate housing," informal settlements continue. Below, we explore some of the key constraints facing user-makers within these settlements. While it is not feasible to survey all constraints within a single article, we have highlighted several key issues below: economic constraints; the navigation of state interventions and the negotiation of intra-community dynamics. Although there is a great deal of diversity within and between informal settlements (Smit 2006), these factors play a role in shaping what residents can achieve as they build and adapt housing within an informal settlement.

First, the decision to build housing within an informal settlement is testament both to an active choice and a "real lack of options" that people face within a context of high unemployment, poverty and inequality (Huchzermeyer 2011, 26). The limited material resources people can obtain is a fundamental factor that shapes their design and construction. For many residents, this means that construction materials are repurposed and reused, based on their accessibility and affordability. A worker near a factory or market, for example, may make use of the wooden pallets used to deliver supplies for their construction (Patel 2013, 277; Cirolia and Scheba 2019, 602). Improvements to informal dwellings are often made incrementally over time. Consequently, the destruction of people's homes through floods, fire, or vandalism can have a devastating impact on these carefully accrued resources: state-provided "basic starter kits" in the aftermath of disasters rarely enabled residents to rebuild to the size and scale of their original dwelling.[10] Persistent exposure to such disasters can dissuade people from making substantial upgrades: in Shukushukuma, for example, one resident described how the tiled floor she had saved to build had been destroyed in the floods. Given that her area was prone to flooding, reinvesting in another tiled floor became unviable.[11] Thus, economic constraints are a crucial limiting factor on user-makers. This is not to argue that informal settlements are economically homogenous: there can be "a high level of social differentiation between households" (Smit 2006, 113). For some residents, resources might not be the most serious limiting factor. Nonetheless, such constraints remain significant.

Second, when designing, adapting, maintaining and improving an informal dwelling, user-makers face a state that cycles between predation, neglect and development. These different forms of state intervention (or lack thereof) directly impact upon the options and constraints user-makers face. Exploring them also highlights two other crucial factors that shape the context in which user-makers operate: tenure insecurity

[10]Block Six Focus Group, 25 March 2019.
[11]Shukushukuma Focus Group, 28 March 2019.

and intra-community dynamics. Below, we address the three facets of state behavior separately, but in practice most residents have experienced all three, sometimes simultaneously.

Predation: Under law, all residents – including those who are unlawfully occupying land or housing – are protected from "arbitrary eviction" (SERI 2017, 10). In South Africa, any eviction requires a court order, which must consider how eviction impacts the evictee's constitutional right to adequate housing as well as related rights, such as the right to human dignity (SERI 2015, 4). In practice, unlawful and violent evictions by state and non-state actors continue (Pithouse 2008; Chance 2018; Cooper-Knock 2018a; Serebin 2020). This often affects new occupations but it can also affect longer-term settlements that the government has refused to recognize as well as those who are deemed to be extending settlements or extending their homes without permission. Such violent regulation of land and housing means that homes in new occupations are constructed quickly and often under a sense of uncertainty and duress. One extreme case, for example, was the settlement of Phumula Mqashi in Gauteng, where Cooper-Knock visited and spoke with residents on several visits in August 2018. Residents in this settlement had repeatedly rebuilt their homes after they were demolished by the police. Over the process of this repeated demolition, both their belongings and their building materials were damaged or confiscated (Cooper-Knock 2018b). Whilst this was an extreme case, it is important to realize that the material costs of demolition and the psychological toll of insecure tenure can deeply affect the structures that user-makers build and the materials they use.

Neglect: As noted above, the state is committed, on paper, to informal settlement upgrading and incremental development (e.g. Western Cape Government 2016). In practice, the extent of material needs, the constraints of financial resources, the sluggishness of bureaucratic processes, and the limits of state capacity, may all combine to make many informal settlement residents feel neglected (Chance, 2018).[12] This neglect often means that residents are left to cope as best they can, with the limited resources that they have. Much then depends both on the individual circumstances of a household, the nature of community mobilization, and the resources available in and around a settlement.[13] In practice, this often means that user-makers are left with a series of risky options to choose between. Let us take, for example, the provision of energy within informal settlements. The supply of electricity by the state has long been a political issue in South Africa (Von Schnitzler 2013). This is particularly true within informal settlements. Many residents see the provision of electricity as a matter of life and death, believing that safe access to affordable and reliable electricity can substantially reduce informal settlement fires (Birkinshaw 2008, 3).[14] And yet, in 2015, a total of 2.1 million homes (formal and informal) were not electrified (Prinsloo 2015, 24–25). If the state is unwilling or unable to provide residents with a source of electricity (Tait n.d.; Gaunt et al. 2012), user-makers are often left with a choice between making informal connections to the grid and using open flames for heating, cooking and lighting.

[12]Ramaphosa Leadership interview, 24 March 2019, Bosasa Leadership interview, 18 July 2019.
[13]Block Six Focus Group, 25 March 2019, Shukushukuma Focus Group, 28 March 2019, California Focus Group, 17 April.
[14]The emphasis on affordable and accessible is crucial here: currently, formal electricity in South Africa is often unaffordable for poorer citizens and can be unreliable. Consequently, many people continue to make some use of informal connections and open-flame technology even where electricity is technically available (SEA 2014, 26).

Both of these options pose fire risks. Open-flame technology makes lethal accidents far more likely: the limited data we have suggests that open flames are the most common cause of informal settlement fires in the country (Anon 2013a, 42–43). All too often, in the discussions around this type of fire, attention will rest on the specter of the drunk resident, who knocks over a candle or leaves a stove on (Pharoah 2009, 113). The implication here is that irresponsible residents are responsible for informal settlement fires. Here again, we see individuals being made responsible for the structural conditions in which they live. In fact, the insight we should draw is that open-flame technologies in contexts of limited space and flammable buildings leave an inhumane margin for error (Chance 2018, 34). And yet, user-makers are often left with few alternatives if affordable and reliable electricity is not available.

The possibility of using an informal electricity connection instead of open-flame technology depends on whether a household can access the grid via a nearby electricity pole or a neighboring formal house.[15] The safety of this option is highly dependent on the skill of those making the connection; whether key infrastructure becomes overloaded; and how communities manage electricity connections across the settlement (i.e. whether wires to houses are buried or suspended) (Murray 2009, 182). If connections are poorly managed, the fire risk in a settlement can increase. In the face of state inaction on the issue of energy provision, user-makers are faced with difficult choices between risky options.

In the example above, residents are forced to choose between different courses of action. In other contexts, the choice might be between inaction and action. Take, for example, the question of whether to upgrade the materials you have used to make your house from tin sheets to block or brick. Millstein's (2020) work suggests that residents think of a "proper house" as a "brick house." Bricks hold a sense of permanency, associated with state-delivered formal housing, and would be likely to inhibit fire spread. Whilst some use of blocks and bricks is not completely absent from informal settlements, sheet metal and wooden poles are by far the most common materials in play (IRIS Fire Survey 2018). More research is needed into what building materials residents use, and why. Kornienko's (2017) study, however, offers some sense of the factors that shape material choices: perceived permanence and security of their tenure; assessment of whether bricks/blocks would spark negative responses from other residents or the state; affordability and accessibility of particular building materials; and whether residents believed they should "wait" for the state instead of upgrading unilaterally. The trade-off that people make between these factors – their fears and expectations, their material possibilities, and their hopes – shapes the materials that they choose. To a high degree, this means that whilst people would prefer a brick house, the home they build relies on sheets and poles.

Developmentalism: Finally, we turn to developmentalism.[16] In one sense, the developmental interventions by the state expand the space within which user-makers can operate: the provision of basic services, for example, can mean that user-makers avoid some of the risky trade-offs noted above. Moreover, the provision of basic services is

[15]Phantsi Kocingo interview, 1 April 2019.

[16]Here we use the term "developmentalism" to mean the interventions that are *made in the name of development*. The term carries no inherent normative meaning.

both a *de facto* recognition of a settlement by the state, and can also be linked to state-issued documents that bolster people's sense of tenure security (Anciano and Piper 2019, 95). There are, however, two caveats to be made. Both relate to the uncertainty of development.

First, development creates uncertainty *for* communities. Even in contexts of in-situ upgrades, there is often a degree of dislocation and displacement involved in the process of development. This might be internal displacement within a settlement or external displacement outside a settlement. Internal displacement occurs when forms of upgrading involve re-blocking, and it can be hugely disruptive to both the physical structures and social relationships in an area (Smit 2006; Massey 2017).

External displacement is even more disruptive, and often occurs when formalization is tied to a process of de-densification (Cirolia et al. 2017). Sometimes, external displacement can mean relocation to a greenfield development site. In other cases, it can mean relocation to a Temporary Relocation Area (TRA), with residents told to await either a return to their original settlement after development, upgrading within the TRA site, or relocation elsewhere. Those who are evicted in the midst of other forms of "development" such as the N2 Gateway Project in Cape Town, may also be relocated to TRAs (Chance 2018, 86–104). TRAs typically provide small, uniform structures, made of sheet metal and wood. They have become infamous in South Africa, on account of the poor living conditions that they offer and the fact that they often stretch the definition of "temporary" (Cirolia 2014, 403). In some ways, they represent the suspension of the role of the user-maker, who is barred from living in a house of their own construction but also unable to access promised development. This is never entirely true, given that community mobilization and individual agency is always possible to some degree (Zweig 2017). Nonetheless, such dislocation and dispossession in the name of development represent a severe constraint on the choices of informal settlement residents.

The physical disruption of development means that even the promise of tenure security in the future can create a sense of insecurity in the present. Thus, we can see how even potentially positive state intervention can create a sense of uncertainty that might leave user-makers unwilling to invest in the relatively expensive materials needed for fire-resistant buildings. Ensuring that tenure remains secure *throughout* the development process would help this issue but in situations where settlements are crowded and re-blocking is necessary this is difficult in practice.

Second, development creates uncertainty *within* communities. As urban scholars have long highlighted, "communities" are never homogenous and unified (Parnell and Oldfield 2014). Within any informal settlement we encounter residents who have different hopes, ideologies, institutional affiliations and material realities (Chance 2018). This means that whilst residents might be relatively united when they are fighting *against* particular forms of oppression, they are less likely to be united when they are working *for* particular forms of development (Oldfield 2002).[17] This situation is complicated by the fact that developmental interventions may heighten the contestation around local leadership within an informal settlement. To understand why, we must understand the political landscape in South Africa.

[17]For a sense of how this plays out in the long term, see Oldfield (2002).

Across the country, the lowest level of representative leadership within government is the Councilor. Each ward Councilor, however, is responsible for a relatively large (and often heterogenous) area, which creates a gap between local communities and the state's representative political structures. This could technically be filled by ward committees, but these have proven to be "exclusive partisan spaces" (Anciano and Piper 2019, 63). The gap between Councilors and citizens is filled by a range of civic organizations, including religious institutions, Community Police Forums, Street Committees, Development Forums, NGOs, and social movements, many of which attempt to assert authority in overlapping areas of community life. Although certain institutions – like street committees – have powerful legacies in particular settlements (Cherry, Jones, and Seekings 2000; Meth 2013), these different organizations are not in any pre-ordained hierarchy with one another (Tshehla 2002): They can all offer a platform for would-be community leaders (Bénit-Gbaffou and Katsaura 2014). Arguably, leadership positions are a source of particularly fierce competition within informal settlements for two key reasons. First, because many everyday issues are decided (at least in part) beyond the reach of state regulation. Second, because informal settlements are sites of potential developmental intervention, which leaders often play a key role in brokering. This brokerage – sometimes informal and sometimes through formal positions such as a Community Liaison Officer – offers key figures the opportunity to exercise political influence and make material gain (Anciano and Piper 2019, 119). In other words, leadership within informal settlements offers the possibility of both pursuing the public good and personal profit (Misago 2017, 45).

This intra-communal contestation introduces a second-tier of insecurity for user-makers in the face of development interventions. Ultimately, any decisions to invest in the material structure of a house must be made in the knowledge of the likely security or insecurity of such investment in the future. The process of upgrading and the contestation surrounding it can add to people's insecurity of tenure. This is perhaps most clearly illustrated in the fallouts that have occurred within Imizamo Yethu, an informal settlement in Hout Bay. Since 2017, Imizamo Yethu has experienced several fires that have destroyed large parts of the settlement. Following these disasters, state officials attempted to instigate re-blocking of the settlement, including the reorganization of households, the building of new roads and the provision of electricity. Although one small area has been re-blocked, this process is largely in deadlock at present thanks to intra-community contestation.[18] Consequently, many residents are living in contexts that are equally-or-more exposed to fire than they once were. They have either rebuilt their homes in their original location – often with limited resources and under the threat of eviction – or they have been forced to adapt the small TRA housing in which they have been located by the state.[19]

Above, we have focused on community contestation at the point of developmental intervention. This does not mean that all upgrading projects are divisive: residents in Sheffield Road, Philippi, for example, report that the process *increased* community cohesiveness (Brown-Luthango, Reyes, and Gubevu 2017, 480–481). Nonetheless, the realization that upgrading *can* prove divisive adds to the cumulative sense of tenure insecurity that an informal settlement resident may have. Moreover, whilst development projects increase the size and scope of negotiations over power and tenure within informal settlements,

[18]Imizamo Yethu Leadership interview 5 May 2018.
[19]Imizamo Yethu resident interview 17 July 2019.

these are never completely absent. In a context of limited state recognition, the ownership, rental or transfer of an informal dwelling is a matter that is primarily negotiated and secured at a settlement level.[20] Occupation can be supported by a letter from the councilor, which can be used with banks or educational establishments that require proof of residence (Patel 2013, 280) but often councilors will only verify what local leaders have already decided.[21] This means that tenure is fundamentally *relational* (Patel 2013, 283). People's capacity to secure good working relationships with local leaders and with their immediate neighbors plays a large role in shaping the parameters of the possible for user-makers.

In sum, this section has sought to provide a sense of some of the key structural constraints facing user-makers within informal settlement. It is impossible to cover all these factors within the space of a single article but above we have highlighted several key issues: economic constraints; the navigation of state interventions and the negotiation of intra-community dynamics. Throughout these discussions, we see how issues like tenure insecurity remain persistently important in shaping the decisions of user-makers. What becomes clear in this process is that fire safety is only one of many of the considerations informal settlements residents address whilst building, alongside factors like the cost and availability of materials, the availability of space, and the need to secure sources of heat, light and power. Moreover, user-makers are constantly having to trade off what developments might be possible today against the medium and long-term insecurities they might face.

5. Potential interventions: asking structurally informed questions

In the previous section, we have highlighted some of the key structural factors that "proximal design" needs to consider when seeking to understand the decisions that user-makers take in relation to fire safety. We have seen that proximal design within informal settlements is the outcome of the broader social, political and economic context in which people live, not just the activities of individual user-makers. Where does this leave us when it comes to assessing the potential interventions that might mitigate fire risk in the short-to-medium term? We argue that a structurally grounded understanding of proximal design does not give us any simple solutions to the fire problem within informal settlements but it can help us to ask more informed questions. We illustrate this argument by focusing on two different types of intervention – fire alarms and re-blocking. We have chosen these two examples because they represent two distinct forms of intervention into informal settlements: technological interventions that leave the material-social structures of a settlement largely unchanged and spatial interventions that explicitly target the socio-spatial organization of a settlement.

5.1. Fire alarms

Perhaps the most successful exemplar of a fire safety technological fix is the smoke alarm. Widespread adoption of smoke alarms in the USA, UK and elsewhere has been accompanied by a marked reduction in fire deaths (e.g. Ahrens 2011). Such an alarm type system has obvious appeal for reducing deaths in informal settlement fires

[20]California resident interview, 26 June 2019.
[21]Often Councillors establish reporting channels with local leaders, e.g. see Meth (2013, 272).

because most deaths are thought to occur in the dwelling where the fire originates, with occupants unable to escape before conditions become lethal.

There are some signs that fire alarms could have a positive impact upon fire safety within informal settlements in South Africa (Verzoni 2018; Zweig et al. 2018; Knight and Chan 2019) but more widespread and longitudinal data is needed. Such research should be guided by the insights that emerge from existing studies and a structurally grounded perspective on "proximal design." First, research must consider how fire alarms interact with the difficult trade-offs that informal settlement residents make. As Meth (2017) argues, for example, a fear of crime often drives residents to invest in locks, window bars and door gates. In the case of a fire, however, these can make it hard for residents to evacuate. This much is true, of course, for residents in all forms of housing. What makes informal settlements unique is the size of the dwelling in question and the speed at which a fire can develop. One test in 2005 suggested that the time from ignition to conditions becoming lethal in a dwelling could be less than a minute.[22] Thus, whilst fire alarms can still be hugely valuable at a settlement level – and organizations like Lumkani have produced inter-linked alarms with this in mind – their effectiveness for individual households is less certain.

Second, alarm development must consider the importance of relational tenure that informal settlement residents need to maintain. False alarms are a universal irritant to neighbors across the globe. Arguably, however, they are particularly problematic in informal settlements both because of the importance that good neighborly relationships play in the viability of everyday life and the frequency with which false alarms can occur where there is widespread use of open-flame technology in relatively small spaces. False positives can lead to informal settlement residents to deactivate their alarms or become desensitized to them (Zweig et al. 2018, 31). Recognizing this, Lumkani has developed their alarm based on heat rather than smoke detection (Knight and Chan 2019), in an effort to reduce false positives. Fire engineers are currently exploring, however, whether this mechanism compromises the warning time people receive to evacuate. This potential trade-off between efficacy and social acceptability is an important reminder that the difficult trade-offs user-makers face as a result of their structural position cannot simply be designed away.

Third, alarm developers need to consider the viability of their technology over time. Alarms need to be resilient to the multiple stresses that informal settlements face, beyond fire (Zweig et al. 2018). They also need to be economically sustainable for residents. In one informal settlement that Cooper-Knock visited, for example, seven of the 10 homes visited had non-functional Lumkani alarms because batteries had run out or been repurposed for battery-driven technology.[23] This repurposing of batteries should not be seen as an example of irresponsible or ill-informed behavior. In situations of economic constraint, such challenges are inevitable and must be tackled at a design level. The difficulty of doing so is, again, a reminder that there is no easy "work around" for the structural constraints that people face.

[22]https://www.youtube.com/watch?v=0Yyn8qHFYD4.
[23]Fieldwork Diary, 27 July 2018.

These three points highlighted above are not intended to be exhaustive but they do demonstrate the utility of taking a structurally informed approach to proximal design when designing technological interventions.

5.2. Reblocking

Re-blocking can be understood as an attempt to restructure the shape of individual dwellings and their location within a settlement in order to enable better access and service provision. In the context of fire safety, this can be particularly important in improving evacuation; allowing access for emergency services; providing safer energy options; and creating fire breaks between dwellings. Since 2013, the City of Cape Town has officially adopted a "reblocking" policy, which Councilor Thandeka Gqada, Mayoral Committee Member for Human Settlements, described as "a turning point in our commitment to redress and a new model of shared responsibility that can change the face of our informal settlements" (Anon 2013c).

Drawing on a structurally informed proximal design perspective enables us to ask important questions about the viability of this re-blocking process. First, what tensions are likely to emerge within communities during the re-blocking process as the socio-spatial reordering heightens tensions around tenure (in)security and creates incentives for contention around leadership positions? How should an awareness of such tensions shape how and when re-blocking processes are initiated? Although re-blocking as a policy is relatively new, our insights into such questions can draw on a much longer literature around incrementalism and in-situ upgrading (Huchzermeyer 2009; Cirolia et al. 2017). These highlight the importance of providing the space and time needed for meaningful community participation in upgrading projects. Contentious issues such as re-blocking cannot be short-circuited by the pressure of top-down intervention or the exigencies of emergency. The deadlocking of re-blocking in Vusimuzi, in the City of Ekurhuleni and Imizamo Yethu, in the Western Cape, is testament to this fact (Cooper-Knock 2018c). The emergence of community consensus is a slow and uncertain process. When thinking through participatory processes and the possibilities of re-blocking it is crucial to think through histories of community mobilization in specific settlements. That said, we must be cautious about thinking of factors like "community cohesion" as static. In their work, Kiefer and Ranganathan (2018, 2) note, "the re-blocking process favours cohesive communities with a history of leadership." Whilst local institutional histories are important, their verdict underestimates the degree to which moments of potential development can produce their own ruptures, even in communities that were previously relatively cohesive, as was the case within Hangberg, in Hout Bay (Anciano and Piper 2019, 106).

Second, how does the need to create space for fire breaks and access fit with the evolving nature of informal settlements? As highlighted above, socio-spatial reorganization can be socially, politically and economically costly. Re-blocking schemes need to consider whether these costs can be justified in terms of the long term benefits that reorganization offers. To do so, we need to take seriously the incremental improvements and extensions that people seek to make to their houses over time. In the re-blocked settlement of California, for example, this ongoing proximal design has begun to erode the gaps

established between some homes in the settlement.[24] In contexts where community leadership is contested, leaders may not be willing or able to intervene in order to stop these extensions. Of course, extending outwards is only one option that user-makers have. Some residents – such as those in Madiba Square in Imizamo Yethu and Mshini Wam in Milnerton – have extended upwards instead.[25] The challenge here, as far as fire safety is concerned, is whether the increased fuel load that a double-story building carries would render the gaps between each dwelling ineffective as a fire break or an evacuation route. Together, what these factors highlight is the danger of seeing fire safety interventions as one-off events rather than a contribution to an ongoing process of proximal design.

Finally, the prospect of re-blocking raises questions around the burden of proof that external interventions must satisfy before they are integrated into processes of proximal design. The fire safety sector in South Africa is awash with social enterprises and NGOs proposing solutions to the problem of informal settlement fires. The difficulty with many such measures, however, is that they have not always been rigorously tested in the environments for which they are proposed in ways that match the burden of proof for state-backed intervention within formal housing.

Intumescent paint, for example, has been proposed by non-profit organizations like Khusela Ikhaya Project,[26] which claims that it "protects homes inside and out with a fire retardant coating that slows down the spread of fire," allowing time for evacuation and for fire services to tackle a blaze. Industrial intumescent paints, however, are typically designed not to inhibit fire spread, but rather to protect structural steel from becoming too hot. In fact, such paints may well increase rather than reduce fire spread due to the manner in which they react to fire to create the protection. Moreover, informal settlement dwellings have windows, doors and other gaps through which flames and radiation can pass, even if the paint does serve some function elsewhere. Current testing is insufficient to allay these fears or to prove whether intumescent paint will prove resilient over time (Walls et al. 2019).

Claims made by the South African SDI Alliance that informal structures "are improved by using high quality Inverted Rib Box ('IRB') galvanised steel sheets with high fire resistance ratings" should be subject to the same scepticism. Fire spread through the material in question may be impeded compared to some other materials, but windows and other gaps, along with burning brands, constitute significant means of fire spread that remain unaddressed. The relative efficacy of IRB compared to other building materials used in proximal design needs to be rigorously tested, with the results of this testing being transparently shared.

The current lack of a publicly shared evidence base creates a double problem. First, it can create a false sense of security for informal settlement residents, which may also affect other decisions that they make around design, construction and everyday life. Second, it raises questions as to whether these interventions are worth the multiple and intersecting costs they require to be implemented. More fundamentally, it points to a double-standard within the fire safety sector, where informal settlement residents – who face a great risk of

[24]California Leadership Interview 27 June 2019.
[25]Imizamo Yethu Resident Interview 16 July 2019, Mshini Wam, site visit, 3 August 2019.
[26]https://www.facebook.com/khuselaikhayaproject/?fref=nf.

fire – are subject to interventions that would not be considered sufficiently rigorous for implementation in formal housing.

6. Discussion

Because informal settlements by their nature develop with little influence from official regulation, their material nature depends greatly on the proximal design carried out by residents. The way in which dwellings are constructed, the maintenance of any fire safety measures, the incidence of fire ignition, and the resulting response to fire, all hinge on the relationship between residents and the technology that constitutes their built environment. To have enduring effectiveness with regard to fire risks any interventions must not only be efficacious when implemented, but also fit into the proximal design practices of the user-makers of informal settlements.

We thus need to go beyond the conception of proximal design as proposed by Usenyuk, Hyysalo, and Whalen (2016), with its narrow focus on individualistic responses to a severe physical environment. Fire safety of the built environment is clearly a collective phenomenon, and focusing on the proximate interaction between user-maker and artifact fails to address the collective dynamics in play within a settlement and the broader structural factors that shape people's everyday lives. This survey of the informal settlement fire problem in the Western Cape, South Africa shows the value instead of viewing proximal design as a socially situated, ongoing process.

Because the social, political and economic context shapes proximal design so strongly in informal settlements, changing the structural context is key to reducing fire risk. The built environment embodies and reflects these people's structural position in society (Murray 2009). One consequence of this is that some members of society are more vulnerable to fires than others. Fire is not a neutral risk that can be understood in purely technical terms, it is also both an outcome and a means of politics (Chance 2015). We must both continue to push for structural political and economic change whilst also exploring mitigating interventions in the short-to-medium term that can tackle the immediate risks people face.

In order to do so effectively we need to go beyond the narrow focus applied by Usenyuk, Hyysalo, and Whalen (2016) towards a structurally informed conceptualization of proximal design. We do so not because this will lead to simple solutions but because centering the experiences of user-makers prompts better questioning of the solutions under consideration. This may, in turn, help shape them to peoples collective and individual needs.

7. Conclusions

The concept of proximal design put forward by Usenyuk, Hyysalo, and Whalen (2016) addresses an important and often overlooked form of innovation, but their focus on cases set in the distinct context of the Russian North results in a conceptual framing that is overly specific. For the concept to be more useful, it should be generalizable across a broader range of settings where user-makers both develop and use technologies. Their emphasis on the mastering of severe or constraining environments is particularly

limiting in the way that it focusses on the physical (e.g. climate and distance) and underestimates the broader social, economic and political constraints that users face.

Applying the concept to understanding the construction of informal settlements and their fire risks highlights critical ways in which proximal design is important, if applied in a way that is truer to the STS origins of the concept. As with the cases from the Russian North, the relationship between people and technology is one where the designers and the users are usually one and the same, as residents of informal settlements engage in ongoing bricolage to build and maintain their dwellings. However, this proximal design does not happen in a vacuum, and nor does it necessarily produce outcomes that are optimal.

We need to view proximal design as a socially (as well as materially) situated process, and our concern with the way that informal settlement users create and use their built environment should not blinker us to the importance of other actors whose influence is apparent if we "study up." Once we take account of this broader social context it is clear that the problem of informal settlement fires in South Africa (and elsewhere) is first and foremost a societal problem born out of urbanization and poverty, and shaped by the priorities and effectiveness of governance in terms of resource allocation, tenure rights, and infrastructure delivery. Ultimately, fire safety in South African Informal settlements can only be secured through the provision of "adequate housing," as envisaged by the constitution. In the interim, short-to-medium term interventions must take account of the structural conditions in which residents operate by including residents in the design of fire safety interventions from their inception.

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Notes on contributors

Graham Spinardi is Senior Lecturer in Engineering and Society in the School of Engineering, University of Edinburgh.

S.J. Cooper-Knock is a Lecturer in International Development in the School of Social and Political Science at the University of Edinburgh and an Research Associate at the University of the Witwatersrand

David Rush, MEng PhD is a Senior Lecturer in Structural Engineering within the School of Engineering at the University of Edinburgh, where he graduated from his masters in 2008, and graduated his PhD in 2013. He publishes research outputs in areas related to structural fire performance, fire safety

engineering, and fire risks in developing nations. David is the Chair of the Structures in Fire Forum, a Member of the IStructE's Research Panel and an EPSRC "Recognising Inspirational Scientists and Engineers" award winner for his research into fires in informal settlements. He is currently the principal investigator on a £1.35M GCRF research grant with the aim of "Improving the Resilience of Informal Settlements to Fire" (IRIS-Fire). He is also a co-investigator on the UKRI's £20M Tomorrow's Cities – Urban Disaster Risk Hub which is looking at multi-hazard risk reduction for the global poor.

ORCID

David Rush http://orcid.org/0000-0002-6439-8607

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